

# FLOW VS SPEED

If the speed of the impeller is increased from  $N_1$  to  $N_2$  rpm, the flow rate will increase from  $Q_1$  to  $Q_2$  as per the given formula:

$$\frac{Q_1}{Q_2} = \frac{N_1}{N_2}$$

# FLOW VS SPEED

The affinity law for a centrifugal pump with the impeller diameter held constant and the speed changed:

**Flow:**

$$Q_1 / Q_2 = N_1 / N_2$$

**Example:**  $100 / Q_2 = 1750/3500$   $Q_2 = 200 \text{ m}^3/\text{hr}$

# HEAD VS SPEED

The head developed(H) will be proportional to the square of the quantity discharged, so that

$$\frac{H_1}{H_2} = \frac{Q_1^2}{Q_2^2} = \frac{N_1^2}{N_2^2}$$

# HEAD VS SPEED

**Head:**

$$H_1/H_2 = (N_1^2) / (N_2^2)$$

**Example:**  $100 / H_2 = 1750^2 / 3500^2$   
 $H_2 = 400 \text{ m}$

# POWER VS SPEED

The power consumed(W) will be the product of H and Q, and, therefore

$$\frac{W_1}{W_2} = \frac{Q_1^3}{Q_2^3} = \frac{N_1^3}{N_2^3}$$

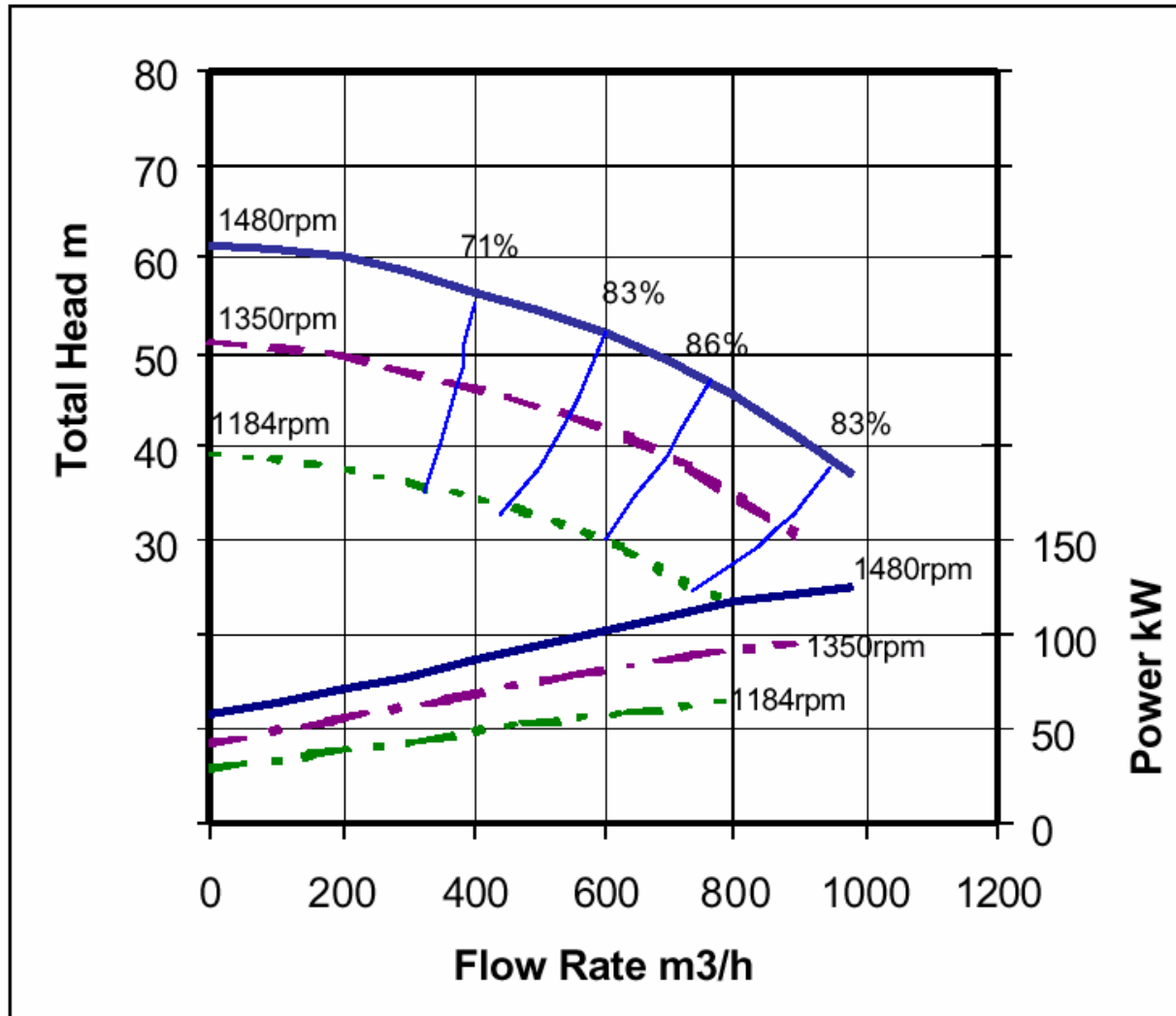
# EFFECT OF SPEED VARIATION

**Power(kW):**

$$\text{kW}_1 / \text{kW}_2 = (\text{N}_1^3) / (\text{N}_2^3)$$

**Example:**  $5/\text{kW}_2 = 17503 / 35003$   
 $\text{kW}_2 = 40$

# EFFECT OF SPEED VARIATION



# THE AFFINITY LAW FOR A CENTRIFUGAL PUMP WITH THE SPEED HELD CONSTANT AND THE IMPELLER DIAMETER CHANGED

## Flow:

$$Q_1 / Q_2 = D_1 / D_2$$

$$\text{Example: } 100 / Q_2 = 8/6$$

$$Q_2 = 75 \text{ m}^3/\text{hr}$$

## Head:

$$H_1/H_2 = (D_1)^2 / (D_2)^2$$

$$\text{Example: } 100 / H_2 = 8^2 / 6^2$$

$$H_2 = 56.25 \text{ m}$$

## Horsepower(BHP):

$$kW_1 / kW_2 = (D_1)^3 / (D_2)^3$$

$$\text{Example: } 5 / kW_2 = 8^3 / 6^3$$

$$kW_2 = 2.1 \text{ kW}$$

# REDUCING IMPELLER DIAMETER

- **Changing the impeller diameter gives a proportional change in peripheral velocity**

# REDUCING IMPELLER DIAMETER

- **Diameter changes are generally limited to reducing the diameter to about 75% of the maximum, i.e. a head reduction to about 50%**
- **Beyond this, efficiency and NPSH are badly affected**